

What is claimed is:

1. A valve opening and closing control device making use of a rotational torque of a motor driven by a motor drive apparatus to control valve opening and closing of an internal combustion engine, the motor drive apparatus comprising

an electric source;

a bridge circuit comprising a plurality of rows of arms comprising two switching elements connected in series to each other and two diodes connected in parallel to corresponding switching elements, the respective arms being connected in parallel to the electric source, the motor having windings thereof connected to points of interconnection of the two switching elements on the respective arms, and

control means for controlling ON/OFF of the switching elements, and

wherein after putting the switching element on one of the two rows of arms in an ON state to carry an electric current to the windings, the control means causes an electricity introduction stoppage element that is one of the two switching elements put in ON state, to be put in an OFF state and causes the separate switching element on the same arm as that, on which the electricity introduction stoppage element is disposed, to be put in an ON state.

2. The valve opening and closing control device according to claim 1, wherein the control means puts the separate switching element on the same arm as that, on which the electricity introduction stoppage element is disposed, in an ON state at later timing than that, at which the electricity introduction stoppage element put in an ON state is put in OFF state.

3. The valve opening and closing control device according to claim 1 or 2, wherein after putting the switching element on one of the two rows of arms in an ON state to carry an electric current to the windings, the control means controls ON/OFF of the switching element selected as the electricity introduction stoppage element by means of the pulse-width modulation method.

4. The valve opening and closing control device according to claim 1, wherein the switching elements comprise a field effect transistor.

5. The valve opening and closing control device according to claim 3, wherein the motor drive apparatus comprises:

the bridge circuit, in which one ends of the respective arms are connected together at a first point of connection, the other ends of the respective arms are connected together at a second point of connection, and the respective arms comprise a load resistive element between the switching element close to the first point of connection and the first point of connection, and

detection means that detects an electric current flowing through the load resistive element of the respective arms.

6. The valve opening and closing control device according to claim 5, wherein the first point of connection is higher in electric potential than the second point of connection.

7. The valve opening and closing control device according to claim 1, wherein valve timing of an internal combustion engine is regulated.

8. The valve opening and closing control device according to claim 1, wherein a maximum valve lift in an internal combustion engine is regulated.

9. The valve opening and closing control device according to claim 2, wherein the motor drive apparatus comprises:

the bridge circuit, in which one ends of the respective arms are connected together at a first point of connection, the other ends of the respective arms are connected together at a second point of connection, and the respective arms comprise a load resistive element between the switching element close to the first point of connection and the first point of connection, and

detection means that detects an electric current flowing through the load resistive element of the respective arms.

10. A motor drive apparatus for controlling windings to thereby rotate an output shaft, the motor drive apparatus comprises:

a bridge circuit comprised of a plurality of arms respectively connected to the windings, wherein each of the plurality of arms comprises a plurality of switching elements connected together in series and a plurality of diodes respectively connected in parallel to the plurality of switching elements, wherein the plurality of arms are connected together at a first point having a first potential and at a second point having a second potential; and

a control circuit connected to the switching elements for sequentially switching the switching elements at a predetermined timing to thereby deliver electric current to the windings, wherein the predetermined timing substantially prevents all of the plurality of switching elements on one of the arms from being on at the same time.

11. The motor drive apparatus of claim 10, wherein the predetermined timing comprises switching one of the switching elements of one of the plurality of arms on for a predetermined time duration and, while the one of the switching elements is on, alternately switching a first switch of the switching elements of another of the plurality of arms on and off for a time duration and alternately switching a second switch of the switching elements of the another of the plurality of arms on and off for the same time duration so that the second switch is off while the first switch is on.